IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
(Docket No: 205.001)

International Application No.: **PCT/EP00/06433**

International Filing Date: **JULY 7, 2000**

Priority Date Claimed: **OCTOBER 6, 1999**

Title: **METHOD FOR MONITORING WIND POWER PLANTS**

Applicant: **WOBBEN**

Commissioner of Patents and Trademarks
Washington, DC 20231

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

Dear Sir:

To effect the filing of the above-referenced application in the United States Patent and Trademark Office as the United States Designated/Elected Office (DO/EO/US), Applicant submits herewith, pursuant to 35 USC 371 et seq. and 37 CFR 1.491 et seq., the following items and other information:

1. **[XX]** This is a FIRST submission of items concerning a filing under 35 USC 371.

2. [ ] This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 USC 371.

3. **[XX]** This is an express request to begin national examination procedures (35 USC 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 USC 371(b) and PCT Articles 22 and 39(1).

4. [ ] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.

5. **[XX]** A copy of the International Application as filed (35 U.S.C. 371(c)(2)):
   a. **[XX]** is transmitted herewith.
   b. **[XX]** has been transmitted by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).

6. [XX] An English translation of the International Application (35 USC 371(c)(3)).

7. [XX] A copy of the International Search Report (PCT/ISA/210), including the references cited therein.

8. [XX] Amendments to the claims of the International Application under PCT Article 19 (35 USC 371(c)(3)):
   a. [XX] are transmitted herewith.
   b. [ ] have been transmitted by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [ ] have not been made and will not be made.

9. [XX] An English translation of the amendments to the claims under PCT Article 19 (35 USC 371(c)(3)).

10. [XX] An unexecuted oath or declaration of the inventor (35 USC 371(c)(4)).

11. [XX] A copy of the International Preliminary Search Report (PCT/IPEA/409).

12. [XX] A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 USC 371(c)(5)), if any.

13. [XX] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.

14. [ ] An assignment document for recording. A separate cover sheet is included.

15. [ ] A preliminary amendment.

16. [ ] A substitute specification.

17. [XX] A power of attorney and/or address letter, see item 18, immediately below.

18. [XX] The communication address with respect to this application is:

Neil Steinberg
Steinberg & Whitt, LLP
2680 Bayshore Parkway, Suite 214
Mountain View, CA 94043

Telephone: 650-968-8079
Facsimile: 650-968-8102

FEE CALCULATION

The following fees are submitted:

Basic National Fee (37 CFR 1.492(a)(1)-(5)):

[XX] International Search Report has been prepared by the EPO or JPO $890.00

[ ] International preliminary examination fee paid to USPTO (37 CFR 1.482) $710.00

[ ] No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) $740.00

[ ] Neither international preliminary examination fee (37 CFR 1.482) nor international search fee paid to USPTO (37 CFR 1.445(a)(2)) $1,040.00

[ ] International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) $100.00

BASIC NATIONAL FEE AMOUNT ..... $ 890.00

Surcharges and Reductions:

[ ] Surcharge of $130.00 for furnishing the oath or declaration later than 20 months or 30 months from the earliest claimed priority date (37 CFR 1.492(e)) ..... $ -0-

[ ] Surcharge for more that 20 total claims (0 x $18.00) ..... $ -0-

[ ] Surcharge for more than 3 independent claims (0 x $84.00) ..... $ -0-

[ ] Surcharge for multiple dependent claims ..... $ -0-

[ ] Reduction of 1/2 for filing by small entity, if applicable ..... $ -0-

[ ] Processing fee of $130.00 for furnishing the English Translation later than 20 or 30 months from the earliest claimed priority date (37 CFR 1.492(f)) ..... $ -0-

TOTAL NATIONAL FILING FEE ..... $ 890.00

FORM OF PAYMENT

Payment of the Total Filing Fee is as follows:

[**XX**] A check payable to the Commissioner of Patents and Trademarks, in the amount of $890.00 is enclosed as payment of the Total Filing Fee.

[ ] Please charge my Deposit Acc. No. 50-0763 in the amount of $_____ to cover the above fees. A duplicate copy of this sheet is enclosed.

[**XX**] The Commissioner is hereby authorized to charge any fees that may be required, or credit any overpayment to Deposit Acc. No. 50-0763. A duplicate copy of this sheet is enclosed.

Respectfully submitted,

Date: April 2, 2002

Neil A. Steinberg
Reg. No. 34,735
Telephone: 650-968-8079

Steinberg & Whitt, LLP
2680 Bayshore Parkway, Suite 214
Mountain View, CA 94043

Bremen	5th July 2000
Our Ref:	W 2175 KGG/MAG/cmu/sb
Applicant/proprietor:	WOBBEN, Aloys
Office Ref:	New application

Aloys Wobben, Argestrasse 19, 26607 Aurich

Method of monitoring wind power installations

The invention concerns a method of monitoring wind power installations, wherein in particular acoustic monitoring is effected.

For effective use of wind power installations, it is advantageous for regulation and operational management of a wind power installation to be carried out in such a way as to ensure fully automatic operation of the installation. Any other mode of operation which requires manual intervention in the normal operating procedure is unacceptable for economic considerations. In order further to increase the economy of the installation, regulation should be effected in such a way that the degree of energy conversion achieved in each operating condition is as high as possible. A further important aspect in terms of regulation and operational management of a wind power installation is operational safety.

Technical faults and environmentally induced danger conditions must be recognised and the safety systems present triggered. In addition a regulating system can contribute to reducing the mechanical loading on the wind power installation.

In terms of monitoring wind power installations it is also desirable if remote analysis can be carried out. That has the advantage that detection of respective operating data can be implemented centrally. Remote monitoring of that kind can lead to an increase in the economy of the installation and an increase in the average availability of the installation. In that situation for example the operating data are interrogated and analysed by a service centre or a remote monitoring centre. By means of analysis of the inputted parameters, it is possible on the one hand to afford early recognition of problems occurring, while on the other hand the operating data can provide important indications regarding the production and wind data for the development department. Analysis of such data by the development department can result in improvements to the wind power installation.

In a known wind power installation for example the following parameters are regularly monitored by sensor means: wind speed, wind direction, air density, rotary speed per minute (average and extreme values), temperatures, currents, voltages, switching pulse, lightning strikes (event counters) etc.

Analysis of the inputted parameters by the remote monitoring centre can result in an improvement in the on-site service as the remote monitoring centre can give the on-site service precise indications in regard to the fault sources.

For further improving maintenance, safety and economy of a wind power installation, it is desirable for further parameters of the wind power installation to be monitored.

Therefore, the object of the invention is to improve monitoring of wind power installations.

In accordance with the invention, that object is attained by acoustic monitoring, in addition to the above-described monitoring of a wind power installation.

The advantages achieved with the invention are in particular that it is possible to implement improved early fault detection in order to avoid consequential damage. That for example can result in the recognition of loose screw connections, electrical faults in the generator area, in regard to the inverter, or in regard to the transformer and wear or icing on the rotor blades at an early stage.

In accordance with the invention, for acoustic monitoring of wind power installations, firstly a reference noise spectrum of an installation or parts thereof is recorded and stored. The operating noise spectrum can be continuously or repetitively recorded during operation and compared to the stored reference spectrum and deviations between those two spectra can be detected. Instead of recording a reference noise spectrum of a wind power installation, it is also possible to have recourse to an already stored reference noise spectrum of a wind power installation.

In accordance with an advantageous embodiment of the invention the detected deviations between the operating and reference noise spectra are communicated to a remote monitoring centre in order to undergo central analysis.

Advantageously likewise the original noises which are recorded by a sound pick-up and which have given rise to the deviation between the operating spectrum and the reference spectrum can be communicated to the remote monitoring centre so that the operating personnel at the centre can themselves check the noises by listening thereto.

In that respect it is particularly advantageous to form a noise pattern from the original noises and in turn to build up an acoustic data bank from those noise patterns.

If the deviations between the operating spectrum and the reference spectrum are greater than a predetermined threshold value the wind power installation is possibly switched off.

An embodiment of the invention is described hereinafter.

In accordance with the invention, in a trial run with a wind power installation, a respective typical reference noise spectrum or reference noise profile of the wind power installation is recorded for given operating ranges such as for example part-load or rated load, and stored in a data memory. In the case of wind power installations of the same structure, it is also possible to use a reference noise spectrum which has already been stored, instead of recording a specific reference noise spectrum for the installation. A plurality of set-up locations for sound pick-ups in the wind power installation are possible, for recording the noise spectrum. For example, it is possible to monitor the rotor blades, the generator or the drive train and the electronics. For the purposes of monitoring the rotor blades, a sound pick-up is mounted for example externally on the tower, for the purposes of monitoring the generator and the drive train a sound pick-up is mounted in the pod and for monitoring the electronics a sound pick-up is mounted in the tower base or in the transformer station. The positions at which the sound pick-ups are set up should not be altered between recording the reference noise spectrum and recording the operating noise spectrum.

In operation of the wind power installation the respective sound (for example as a frequency spectrum of between 0.1 Hz and 30 KHz) is recorded in dependence on the operating point or working range such as for example from 0 KW to the rated power output. That operating sound is compared to the reference noise spectrum and evaluated.

When the operating noise spectrum is detected, the working range or the operating range of the wind power installation is firstly determined in order to compare the operating noise spectrum of the respective range to the corresponding reference noise spectrum. If in that situation there

are deviations which exceed a predetermined threshold value, a fault message is produced, which is signalled to the remote monitoring centre and possibly the wind power installation is shut down automatically or manually (by the centre).

When detecting a deviation between the operating noise spectrum and the reference noise spectrum, which exceeds the threshold value, then a fault message is communicated to the remote monitoring centre, as described above. Accurate analysis of the fault message or the deviations can be implemented in the remote monitoring centre. The operating staff in the remote monitoring centre can possibly react quickly to the fault message and communicate that fault message to the maintenance staff on site. In that way early fault detection can take place in good time and faults of that kind can be quickly dealt with by the maintenance staff. In addition consequential damage can be avoided in that way. The average availability of the installation and thus the economy of the installation can be increased by such an improvement in maintenance and upkeep of the wind power installation.

In order to improve fault diagnosis the original noise which was recorded by a sound pick-up and which caused the deviation between the operating spectrum and the reference spectrum can be communicated to the remote monitoring centre. There the operating staff can listen to the noises in question, in a more sophisticated and subtly differentiated manner, and possibly implement suitable measures. A procedure of that kind is desirable as the human ear reacts more sensitively and more selectively to given noises than a signal processing device.

To relieve the load on the operating staff of the remote monitoring centre, noise patterns can be formed from the original noises (audio signals) and an acoustic data bank can be built up from those patterns. A signal processing device compares the recorded noises of a wind power installation with the stored noise patterns and already implements a pre-selection among the possible fault causes. For example the recorded

audio signals can be digitised and converted into noise patterns and then subjected to further digital processing. The operating staff of the remote monitoring centre can thus listen to the noise and in that situation already have at hand possible fault causes suggested by the signal processing device. That procedure can result in an improvement to and a relief of load at the workplace for the operating staff of the remote monitoring centre and make the monitoring procedure more efficient.

In addition, it is possible to obtain information about the cause and the variation in respect of time of a fault, by building up a data bank in which all deviations between the operating noise spectrum and the reference noise spectrum are stored in respect of time. In addition the data of that data bank can be compared to data of the other operating parameters such as for example wind speed, temperature, current, voltage and so forth. A correlation in regard to fault development can possibly be found from the comparison of such data. Indications of that kind would be very valuable from the point of view of the development department as that knowledge can be used when developing fresh installations and in the further development of existing installations.

New claims

1. A method of acoustically monitoring wind power installations, comprising the steps:

recording a reference noise spectrum of a wind power installation and/or parts thereof at at least one given location of the installation,

storing said reference spectrum in a storage means,

recording the operating noise spectrum during operation at the given location or locations of the installation,

comparing the recorded operating noise spectrum to the stored reference spectrum,

detecting deviations between the operating noise spectrum and the reference spectrum,

communicating the detected deviations between the operating noise spectrum and the reference spectrum to a remote monitoring centre, and

communicating the noises which caused the deviations between the operating spectrum and the reference spectrum to the remote monitoring centre.

2. A method of acoustically monitoring wind power installations, comprising the steps:

storing a reference noise spectrum of a wind power installation and/or parts thereof in a storage means,

recording the operating noise spectrum during operation at the given location or locations of the installation,

comparing the recorded operating noise spectrum to the stored reference spectrum,

detecting deviations between the operating noise spectrum and the reference spectrum,

communicating the detected deviations between the operating noise spectrum and the reference spectrum to a remote monitoring centre, and

communicating the noises which caused the deviations between the operating spectrum and the reference spectrum to the remote monitoring centre.

3. A method according to claim 1 or claim 2 wherein the operating noise spectrum is continuously or repetitively recorded during operation at the given location or locations of the installation.

4. A method according to claim 1, claim 2 or claim 3 wherein noise patterns are formed from the original noises and an acoustic data bank is built up from said noise patterns.

5. A method according to claim 1 or claim 2 wherein the wind power installation is shut down if the deviations between the operating spectrum and the reference spectrum exceed a predetermined threshold value.

6. A wind power installation in which the acoustic monitoring method according to claims 1 to 5 is applied, comprising

at least one sound pick-up at at least one given location of the installation for one-time recording of the reference noise spectrum and for continuously recording the operating noise spectrum of the wind power installation and/or parts thereof,

a storage means for storing the reference spectrum of the installation,

a data processing means for comparing the recorded operating noise spectrum to the stored reference spectrum and for detecting deviations between the operating noise spectrum and the reference spectrum, and

a communicating device for communicating the detected deviations between the operating noise spectrum and the reference spectrum to a remote monitoring centre and communicating the noises which caused the deviations between the operating spectrum and the reference spectrum to the remote monitoring centre.

Abstract

For effective use of wind power installations, it is advantageous for regulation and operational management of a wind power installation to be carried out in such a way as to ensure fully automatic operation of the installation. Any other mode of operation which requires manual intervention in the normal operating procedure is unacceptable for economic considerations. In order further to increase the economy of the installation, regulation should be effected in such a way that the degree of energy conversion achieved in each operating condition is as high as possible. A further important aspect in terms of regulation and operational management of a wind power installation is operational safety. Technical faults and environmentally induced danger conditions must be recognised and the safety systems present triggered. In addition a regulating system can contribute to reducing the mechanical loading on the wind power installation.

For further improving maintenance, safety and economy of a wind power installation, it is desirable for further parameters of the wind power installation to be monitored. Therefore, the object of the invention is to improve monitoring of wind power installations.

A method of acoustically monitoring wind power installations, comprising the steps: recording a reference noise spectrum of a wind power installation and/or parts thereof at at least one given location of the installation, storing said reference spectrum in a storage means, recording the operating noise spectrum during operation at the given location or locations of the installation, comparing the recorded operating noise spectrum to the stored reference spectrum, and detecting deviations between the operating noise spectrum and the reference spectrum.

DECLARATION AND POWER OF ATTORNEY

As a below-named inventor, I hereby declare that:

My residence, mailing address, and citizenship are as stated below next to my name.

I believe that I am an original, first and joint inventor of the inventions described and claimed in the specification which was filed on April 2, 2002, assigned U.S. Application Serial No. 10/089,774, and entitled:

METHOD FOR MONITORING WIND POWER PLANTS

the specification of which was filed as PCT International Application No. PCT/EP00/06433 on July 7, 2000, and was amended on November 26, 2001.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 USC 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 35 USC 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below any foreign application for patent or inventor's certificate or of any PCT international application filed by me or my assignee disclosing the subject matter claimed in this application and having a filing date before that of the application on which priority is claimed:

PRIOR FOREIGN APPLICATION(S)

Application No.	Country	Filing Date	Priority Not Claimed
DE 199 48 194.6	Germany	6 October 1999	
PCT/EP00/06433	PCT	7 July 2000	

I hereby claim the benefit under 35 USC 120 of any United States application(s), or 35 USC 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in such prior applications in the manner provided by the first

W2623

paragraph of 35 USC 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. PARENT APPLICATION OR PCT PARENT NUMBER

Application No.	Filing Date	Parent Patent Number
PCT/EP00/06433	7 July 2000	

I hereby appoint Neil A. Steinberg, Reg. No. 34,735, who is a member of the Bar of the Commonwealth of Massachusetts and the District of Columbia, with full power of substitution and revocation to transact all business in the U.S. Patent and Trademark Office connected therewith. The current mailing address and telephone number of Neil A. Steinberg are:

Neil Steinberg
Steinberg & Whitt, LLP
2680 Bayshore Parkway
Suite 214
Mountain View, CA 94043

Telephone: 650-968-8079
Facsimile: 650-968-8102

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Inventor: 1-00 **Aloys Wobben**

Residence: Argestrasse 19
D-26607 Aurich, Germany DEX

Citizenship: German

Mailing Address: Argestrasse 19
D-26607 Aurich, Germany

Date: 21.5.2002

Aloys Wobben